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FUTURE NEEDS FOR HYDROLOGIC DATA

Elmo W. Huffman, et al

Pacific Southwest Inter-Agency Committee
Sacramento, California

July 1968

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PB 214 996

Pacific Southwest
INTER-AGENCY COMMITTEE

Report of the Water Management Subcommittee

FUTURE NEEDS for HYDROLOGIC DATA

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24

PACIFIC SOUTHWEST INTER-AGENCY COMMITTEE

WATER MANAGEMENT SUBCOMMITTEE

REPORT

ON

FUTURE NEEDS FOR HYDROLOGIC DATA

Sacramento, California
July 1968

FUTURE NEEDS FOR HYDROLOGIC DATA

FOREWORD

This report on Future Needs for Hydrologic Data was prepared by the Water Management Subcommittee of the Pacific Southwest Inter-Agency Committee to help water resource agencies in the Pacific Southwest improve the effectiveness and efficiency of their hydrologic data programs. It is based on the responses on 732 questionnaires from planners, designers, administrators, operators, and researchers representing nearly all, if not actually all, of the water resource agencies and companies in the region.

About 3,000 questionnaires were distributed. Each agency was provided with a supply in order to obtain as wide a response as possible. There was a good response from the agencies, but as a rule each non-federal or non-state agency returned only one completed questionnaire. This is especially the case for water and power companies and districts.

This report was prepared for the Water Management Subcommittee by a Task Force on Future Needs for Hydrologic Data composed of the following members:

Elmo W. Huffman, California Department of Water Resources, Sacramento, California, Chairman.

Robert B. Hickok, Agriculture Research Service, USDA, Tucson, Arizona.

Eugene L. Peck, U.S. Weather Bureau, ESSA, Silver Springs, Maryland.

The task force hereby expresses its appreciation to all who responded to the questionnaire.

FUTURE NEEDS FOR HYDROLOGIC DATA

INTRODUCTION

The purpose of this task force was to collect and summarize the opinions of individuals in the field of water resources with regard to the present adequacy and future needs of basic data in hydrometeorology. This was accomplished by a questionnaire which is shown on pages A-1 and A-2 of the Appendix. The questionaire was designed so that the data could be readily punched and analyzed. Decks of cards are available to interested agencies from the Water Management Subcommittee. These 2,928 cards may be distributed in a variety of ways other than for this report.

Analyses of the completed questionnaires should provide informative consensus on the needs of future hydrologic data in the Pacific Southwest region. Sample analyses of the data are presented to demonstrate the value of the information as a tool for optimizing basic data and research data requirements for a specific category of activity. Each agency should be able to apply the general results to its own hydrologic data program. Other analyses which can be made by other distributions to the cards, may provide more specific information for particular fields of interest.

ANALYSIS OF QUESTIONNAIRE

Format of Questionnaire

This questionnaire is divided into three sections. Section 1 (A-1) provides opportunity to identify the

background of each responder as to his agency, the geographic area of concern, his main hydrometeorlogical responsibility, and his field of interest. Section II (A-1) is designed to determine the adequacy of the basic data for anticipated future needs. Section III (A-3) asks for possible ways to improve basic data for many hydrometeorological problem areas. The areas of potential improvement include areal coverage, density of network, new types of basic data, and additional research.

Nature of Response

Analyses of the completed questionnaires received from 732 responders were made by absolute numbers and by percentages of total answers received by all resplies. The cards were distributed by categories of primary concern as shown in Group C of Section I. The distributions, based on percentages, are shown in the Appendix as follows:

Category of Concern	No. of Responses	Pages in Appendix
All resplies	732	A-3, A-4
Planning	240	A-5, A-6
Design	69	A-7, A-8
Administration	99	A-9, A-10
Operations	146	A-11, A-12
Research	100	A-13, A-14

To highlight the results, percentages of 30 percent or greater have been marked for Section II, and those of 20 percent or greater have been marked for Section III. The area of principal interest and the answers which most nearly represent the overall opinions may be readily seen.

Adequacy of Present Basic Data

Based on All Replies

A distribution of all replies to the questionnaire as a percentage of the total responses for each category and item is shown on pages A-3 and A-4. The answers in Part I of the questionnaire seem to follow the general pattern that would be expected, i.e., most who replied were those from federal agencies (45 percent), followed by those from state agencies (23 percent). Most of those replying worked in the field of water supply (57 percent), flood protection (33 percent), or with pollution control (32 percent).

It is interesting to note, as shown on page A-3, that most types of data listed in Part II, "present basic data," were responded to by a sizable percentage of those returning questionnaires. Greatest attention was given to the section on rainfall, with a notable lack of interest in those sections dealing with meteorlogical factors such as dew and fog measurement, humidity, wind and weather conditions. All percentages of 30 percent or greater have been marked on Part II of the form for all distributions. In general, they were in agreement that specific types of data were either inadequate or about right. No greater than 1 percent of the replies indicated that we have too much basic data of any type. The inadequacy of evaporation data from free water bodies received the highest

percentage of answers (46 percent), while precipitation intensity measurements received the next highest percentage (43 percent). Inadequate data were also generally noted for other items in the sections on evaporation, surface water movement or storage, sedimentation, and ground water and soil moisture.

For the problem areas listed in Part III, those replying felt that basic research, rather than the extension of present networks, is most needed to obtain information required for solutions.

Based on Area of Responsibility

Planners supported the need for more adequacy in data in the fields of subsurface water, sedimentation, evaporation, time of travel of surface water, and rainfall intensity.

Designers expressed a great need for better rainfall intensity measurements, more adequate surface water data of the type closely related to channel hydraulics, and significant concern for sedimentation data. Administrators were strongest for adequate evaporation, sedimentation, and subsurface hydrology data. Water Quality and stream discharge data round out their greatest concern. Operators are mainly concerned for more adequate evaporation, time of surface water travel, subsurface hydrology data, rainfall intensity measurements, chemical water quality, and surface water hydrology.

In general, researchers expressed greater dissatisfaction with present basic data of nearly all types than was expressed by all other users. They expressed greatest concern for better evaporation, subsurface hydrology, radiation, chemical quality of water, and time of travel of surface water.

In summary, the sedimentation phenomena received particular attention from all groups, with strong agreement in their inadequacy for future needs. Ground water and soil moisture received a large response from most of the responding groups who believed present data to be inadequate for future needs. Evaporation from free water bodies and evapotransiration data were especially thought to be inadequate. Even the small response from designers agreed they were inadequate.

The research groups were the only one foreseeing a strong need for more radiation data. In fact, all the other groups showed only moderate interest in this subject. The response was large from all groups for snow measurements and, except for the research groups, these measurements were thought to be adequate. Rainfall intensity data were thought to be particularly inadequate for future needs by all groups in the report.

Dew, fog, and humidity data received the lowest response and, in most instances, more thought them adequate than otherwise.

6. PACIFIC SOUTHWEST INTER-AGENCY COMMITTEE

Administrators were most interested in more adequate water quality data, however, in general all groups thought they were somewhat inadequate.

Except for researchers, slightly more responders thought temperature data were adequate than otherwise.

Surface water movement and storage items received a mixed response from most groups. All but the operators were dissatisfied with present streamflow data, while all groups seemed content with present tide and reservoir data.

As a rule, about as many thought that wind data were adequate as thought otherwise.

Most responders from all groups thought that weather conditions data were adequate.

Potential for Greatest Improvement

Greater areal coverage of present types of data was thought to be most valuable for storm precipitation and for assessing the general water resources of an area. Designers suggest greater areal coverage for flood data, while administrators and researchers would expand surface water chemical quality networks.

Storm precipitation data could also be enhanced by increased density of present networks. Designers would use increased density to develop precipitation-basin relationships, while researchers would use this means to get better ground water chemical quality.

There was no strong emphasis on the collection of new types of basic data, however, greatest concern was with what happens to precipitation when it reaches the ground surface. Designers wanted to know more about hydraulics and geometry of channels, while administrators were most interested in new data to define ground water basin storage. Of all groups, researchers were most interested in new types of data of nearly all kinds. In general, areas requiring more research are ground water recharge, watershed management factors, runoff from precipitation, vegetative effects on sediment production, and soil moisture movement. Operators saw least improvement from research, while researchers saw moderate to great possibilities for improvement for nearly every area of interest.

PACIFIC SOUTHWEST INTER-AGENCY COMMITTEE

WATER MANAGEMENT SUBCOMMITTEE

FUTURE NEEDS FOR HYDROLOGIC DATA

APPENDIX

Item	Page
Copy of Questionnaire	A-1 , A-2
All Replies by Percentages	A-3 , A-4
Replies from Planners by Percentages	A-5 , A-6
Replies from Designers by Percentages	A-7 , A-8
Replies from Administrators by Percentages	A-9 , A-10
Replies from Operators by Percentages	A-11 , A-12
Replies from Researchers by Percentages	A-13 , A-14

PACIFIC SOUTHWEST INTER-AGENCY COMMITTEE
WATER MANAGEMENT SUBCOMMITTEE
HYDROLOGY WORK GROUP

QUESTIONNAIRE ON FUTURE HYDROLOGIC DATA NEEDS

Answer only those items which apply to your work. Circle the number or numbers corresponding to your answer. Numbers are for card punching.

Send completed form to: Elmo W. Huffman
Room 215-22; 1416 9th Street
P. O. Box 388
Sacramento, California 95802

Identification number and card sequence (1) (2) (3) (4) (5) ____ 1

I. Nature of response:

A. I am associated with which type of organization: (Circle one)
6-1 Federal Agency
6-2 State Agency
6-3 University or College
6-4 Local Government (City, County, District,-)
6-5 Private (non-profit)
6-6 Private (profit)
6-7 Research Institute
6-8 Other-specify____

B. Geographic area of concern: (Circle one)
7-1 Entire Pacific Southwest
7-2 Particular Basin*
7-3 System of basins*
7-4 State*
7-5 Other*
* Identify____

C. I am primarily concerned with: (Circle one)
8-1 Planning
8-2 Design
8-3 Administration
8-4 Operations
8-5 Research
8-6 Other-specify____

D. I work in the following fields: (Circle as applicable)

Water Supply	9
Soil Conservation	10
Reclamation	11
Flood Protection	12
Forecasting	13
Power	14
Water Rights	15
Navigation	16
Pollution Control (Water Quality)	17
Recreation	18
Fish and Wildlife	19
Watershed Management	20
Agriculture	21
Forestry	22
Other-specify____	23

II. Present basic data: Considering anticipated future development and conservation of land, water, and related resources, present basic data are believed to be:

	Inadequate	About Right	Too Much
Rainfall			
Daily measurements (for seasonal totals)	24-1	24-2	24-3
Intensity measurements	25-1	25-2	25-3
Chemical quality	26-1	26-2	26-3
Susp. solids in rainfall	27-1	27-2	27-3
Other	28-1	28-2	28-3
Specify____			
Snow			
Total snowfall	29-1	29-2	29-3
Depth on the ground	30-1	30-2	30-3
Water equivalent	31-1	31-2	31-3
Physical properties	32-1	32-2	32-3
Other	33-1	33-2	33-3
Specify____			
Dew and Fog Measurements			
Dew measurements	34-1	34-2	34-3
Fog drip	35-1	35-2	35-3
Other	36-1	36-2	36-3
Specify____			
Humidity			
Relative humidity	37-1	37-2	37-3
Dew point	38-1	38-2	38-3
Wet bulb	39-1	39-2	39-3
Precipitable water	40-1	40-2	40-3
Other	41-1	41-2	41-3
Specify____			

	Inadequate	About Right	Too Much
Temperature			
Free air (Mr. ground)	42-1	42-2	42-3
Upper air	43-1	43-2	43-3
Surface (of ground)	44-1	44-2	44-3
Frost (occurrence dates)	45-1	45-2	45-3
Soil (below surface)	46-1	46-2	46-3
Reservoirs and lakes	47-1	47-2	47-3
Streams	48-1	48-2	48-3
Ground water	49-1	49-2	49-3
Other	50-1	50-2	50-3
Specify____			
Surface Water Movement or Storage			
Time of travel	51-1	51-2	51-3
Stream velocity	52-1	52-2	52-3
Stream discharge	53-1	53-2	53-3
Streamflow volumes	54-1	54-2	54-3
Flood crest heights	55-1	55-2	55-3
Flood wave velocity	56-1	56-2	56-3
Stream and tidal stage	57-1	57-2	57-3
Lake or reservoir stage	58-1	58-2	58-3
Lake or reservoir volume	59-1	59-2	59-3
Interflows*	60-1	60-2	60-3
Other	61-1	61-2	61-3
Specify____			

*Interflows are percolating waters reaching streams without first reaching a ground water body.

	Inadequate	About Right	Too Much
Ground Water and Soil Moisture			
Soil moisture amount	62-1	62-2	62-3
Phreatic surfaces (unconfined)	63-1	63-2	63-3
Piezometric surfaces (confined)	64-1	64-2	64-3
Extractions (pumping)	65-1	65-2	65-3
Transmissibility	66-1	66-2	66-3
Percolation	67-1	67-2	67-3
Permeability	68-1	68-2	68-3
Specific yield	69-1	69-2	69-3
Other	70-1	70-2	70-3
Specify____			
Radiation			
Incoming shortwave	71-1	71-2	71-3
Long wave (to surface)	72-1	72-2	72-3
Net radiation	73-1	73-2	73-3
Albedo	74-1	74-2	74-3
Sunshine	75-1	75-2	75-3
Cloudiness	76-1	76-2	76-3
Other	77-1	77-2	77-3
Specify____			

(1) (2) (3) (4) (5) ____ 2

	Inadequate	About Right	Too Much
Evaporation			
From free water bodies	6-1	6-2	6-3
Evaporimeter	7-1	7-2	7-3
Evapotranspiration (point measurement)	8-1	8-2	8-3
Evapotranspiration (areal measurement)	9-1	9-2	9-3
From bare ground	10-1	10-2	10-3
Other	11-1	11-2	11-3
Specify____			
Quality of Water			
Chemical	12-1	12-2	12-3
Physical	13-1	13-2	13-3
Biological	14-1	14-2	14-3
Radiological	15-1	15-2	15-3
Bacteriological	16-1	16-2	16-3
Organic	17-1	17-2	17-3
Other	18-1	18-2	18-3
Specify____			

	Inadequate	About Right	Too Much
Wind			
Upper air velocity	19-1	19-2	19-3
Near surface velocity	20-1	20-2	20-3
Prevailing direction (by day, month, or season)	21-1	21-2	21-3
Extreme winds	22-1	22-2	22-3
Total air movement	23-1	23-2	23-3
Other	24-1	24-2	24-3
Specify____			
Sedimentation			
Sediment production at source	25-1	25-2	25-3
Suspended sediment	26-1	26-2	26-3
Bedload transport	27-1	27-2	27-3
Total sediment transport	28-1	28-2	28-3
Stream channel aggradation and degradation	29-1	29-2	29-3

	Inadequate	About Right	Too Much
Lake and reservoir deposition	30-1	30-2	30-3
Other	31-1	31-2	31-3
Specify____			
Weather Conditions			
Fogginess	32-1	32-2	32-3
Hail	33-1	33-2	33-3
Glaze and rime ice storms	34-1	34-2	34-3
Pressure (barometric)	35-1	35-2	35-3
Other	36-1	36-2	36-3
Specify____			

III. There are many problem areas in hydrometeorology where the state of the art is not adequate to define the relationships. Listed below are several problem areas or basic data fields where additional information may be needed for use in solving various problems in hydrometeorology. Which action would yield the most good?

Area of Interest	Could be most significantly improved by: Greater Areal Coverage of Present Type of Data	Increased Density of Network in Present Areas	New Types of Basic Data	Additional Basic Research
Areal distribution of storm precipitation	37	38	39	40
Relation of precipitation intensities and total amounts to basin characteristics, orographic and other	45	46	47	48
Interception	53	54	55	56
Entry of precipitation and surface runoff into underground storage (recharge)	61	62	63	64
Evapotranspiration	69	70	72	72
Interchanges of water between surface and zone of saturation	77	78	79	80
(1) (2) (3) (4) (5) ___ ___ ___ ___ 3				
Phreatophyte consumption of water	6	7	8	9
General water resource of an area	14	15	16	17
Vegetative cover effects on streamflow	22	23	24	25
Hydraulics and geometry of channels	30	31	32	33
Stream stage forecasting	38	39	40	41
Physical quality of surface waters	46	47	48	49
Biological quality of surface waters	54	55	56	57
Bacteriological quality	62	63	64	65
Erosion and sediment production at source	70	71	72	73
(1) (2) (3) (4) (5) ___ ___ ___ ___ 4				
Bedload and total load movement in stream	6	7	8	9
Land use effects on sediment production	14	15	16	17
Ground water movement	22	23	24	25
Physical quality of ground water	30	31	32	33
Biological quality of ground water	38	39	40	41

Area of Interest	Could be most significantly improved by: Greater Areal Coverage of Present Type of Data	Increased Density of Network in Present Areas	New Types of Basic Data	Additional Basic Research
Depth-area duration of precipitation	41	42	43	44
Cyclic and/or stochastic variations in meteorological parameters	49	50	51	52
Land surface influences on generation of runoff from precipitation	57	58	59	60
Lake evaporation	65	66	67	68
Interflow (See 2.D. 8.)	73	74	75	76
Bank storage	10	11	12	13
Water supply forecasting	18	19	20	21
Urbanization effects on runoff	26	27	28	29
Flood frequency	34	35	36	37
Flood hydrograph and overflow characteristics of streamflow (including areal flooding, detention, etc.)	42	43	44	45
Chemical quality of surface waters	50	51	52	53
Radiological quality	58	59	60	61
Organic	66	67	68	69
Suspended sediment transport in streams	74	75	76	77
Vegetation cover effects on sediment production	10	11	12	13
Soil moisture movement	18	19	20	21
Ground water basin storage	26	27	28	29
Chemical quality of ground water	34	35	36	37
Other (specify)	42	43	44	45

IV. My agency would like to receive a copy of the summary of this study when completed.

Yes ( ) No ( )

V. Comments on a separate sheet on the basic data and research requirements for solution of problems listed in Section III would be appreciated. Please indicate by name which items you are referring to. Comments should include the extent to which you feel the present networks should be increased, the types of new data that might be required, and/or the type of basic or development research that would be needed, etc.

NAME_____

TITLE_____

ORGANIZATION_____

ADDRESS_____

PACIFIC SOUTHWEST INTER-AGENCY COMMITTEE
WATER MANAGEMENT SUBCOMMITTEE

Summary of
QUESTIONNAIRE ON FUTURE HYDROLOGIC DATA NEEDS

ALL REPLIES
Figures Shown are Percentages of 732 Replies

I. Nature of response:

A. I am associated with which type of organization: (Circle one)

Federal Agency	45
State Agency	23
University or College	8
Local Government (City, County, Dist.)	15
Private (non-profit)	1
Private (profit)	5
Research Institute	0.1
Other	2
No Answer	1

B. Geographic area of concern: (Circle one)

Entire Pacific Southwest	14.5
Particular Basin*	23
System of basins*	18
State*	27
Other*	14.5
No Answer	3

C. I am primarily concerned with: (Circle one)

Planning	33
Design	9
Administration	14
Operations	20
Research	14
Other-specify	6
No Answer	4

D. I work in the following fields: (Circle as applicable)

Water Supply	57
Soil Conservation	20
Reclamation	16
Flood Protection	33
Forecasting	15
Power	9
Water Rights	24
Navigation	3
Pollution Control (Water Quality)	32
Recreation	22
Fish and Wildlife	14
Watershed Management	23
Agriculture	25
Forestry	6
Other	10

II. Present basic data: Considering anticipated future development and conservation of land, water, and related resources, present basic data are believed to be:

	Inadequate	About Right	Too Much
Rainfall			
Daily measurements (for seasonal totals)	29	51	0.1
Intensity measurements	43	22	0.3
Chemical quality	21	17	0.6
Susp. solids in rainfall	13	14	0.8
Other	2	4	0.1
Snow			
Total snowfall	18	37	0.1
Depth on the ground	17	33	0.3
Water equivalent	24	31	0.3
Physical properties	11	15	0.4
Other	4	4	0.3
Dew and Fog Measurements			
Dew measurements	13	14	0.7
Fog drip	11	13	0.8
Other	1	7	0.3
Humidity			
Relative humidity	15	24	0.4
Dew point	13	18	0.3
Wet bulb	10	17	0.4
Precipitable water	13	11	0.3
Other	0.8	3	0.1
Evaporation			
From free water bodies	46	16	1
Evaporimeter	21	11	0.8
Evapotranspiration (point measurement)	35	10	0.7
Evapotranspiration (areal measurement)	41	8	0.3
From bare ground	33	9	0.4
Other	[illegible]	3	0.1
Quality of Water			
Chemical	32	26	1
Physical	24	18	0.8
Biological	26	14	0.4
Radiological	16	15	0.8
Bacteriological	21	15	0.6
Organic	21	12	0.3
Other	4	5	0.3

	Inadequate	About Right	Too Much
Temperature			
Free air (Nr. ground)	18	33	0.6
Upper air	14	18	0.1
Surface (of ground)	17	18	0.1
Frost (occurrence dates)	13	27	0.4
Soil (below surface)	22	13	0.3
Reservoirs and lakes	21	18	0.6
Streams	20	20	0.3
Ground water	16	18	0.3
Other	2	5	0.1
Surface Water Movement or Storage			
Time of travel	40	14	0.1
Stream velocity	29	21	0.1
Stream discharge	36	30	0.4
Streamflow volumes	34	28	0.3
Flood crest heights	29	23	0.3
Flood wave velocity	26	13	0.1
Stream and tidal stage	12	21	0.1
Lake or reservoir stage	10	33	0.3
Lake or reservoir volume	11	33	0.3
Interflows*	25	7	0
Other	1	3	0

*Interflows are percolating waters reaching streams without first reaching a ground water body.

	Inadequate	About Right	Too Much
Wind			
Upper air velocity	14	16	0.3
Near surface velocity	25	17	0.7
Prevailing direction (by day, month, or season)	17	20	0.6
Extreme winds	16	16	0.4
Total air movement	13	13	0.3
Other	2	3	0.1
Sedimentation			
Sediment production at source	41	8	0.1
Suspended sediment	35	12	0.4
Bedload transport	30	9	0.6
Total sediment transport	37	9	0.6
Stream channel aggradation and degradation	37	8	0.1

	Inadequate	About Right	Too Much
Ground Water and Soil Moisture			
Soil moisture amount	39	12	0.3
Phreatic surfaces (unconfined)	27	12	0.6
Piezometric surfaces (confined)	26	11	0.4
Extractions (pumping)	30	15	0.4
Transmissibility	36	7	0.3
Percolation	40	9	0.3
Permeability	42	9	0.4
Specific yield	35	9	0.3
Other	3	2	0.1
Radiation			
Incoming shortwave	18	8	0.4
Long wave (to surface)	19	7	0.4
Net radiation	22	7	0.4
Albedo	16	8	0.3
Sunshine	13	12	0.4
Cloudiness	13	12	0.3
Other	2	2	0.3
Lake and reservoir deposition	31	11	0.6
Other	3	3	0.3
Weather Conditions			
Fogginess	6	21	0.3
Hail	6	19	0.6
Glaze and rime ice storms	4	18	0.4
Pressure (barometric)	5	22	0.1
Other	2	7	0.1

III. There are many problem areas in hydrometeorology where the state of the art is not adequate to define the relationships. Listed below are several problem areas or basic data fields where additional information may be needed for use in solving various problems in hydrometeorology. Which action would yield the most good?

Area of Interest	Could be most significantly improved by:			
	Greater Areal Coverage of Present Type of Data	Increased Density of Network in Present Areas	New Types of Basic Data	Additional Basic Research
Areal distribution of storm precipitation	[redacted]21	[redacted]24	5	10
Relation of precipitation intensities and total amounts to basin characteristics, orographic and other	13	16	6	18
Interception	5	5	5	12
Entry of precipitation and surface runoff into underground storage (recharge)	10	10	10	[redacted]24
Evapotranspiration	12	11	6	[redacted]23
Interchanges of water between surface and zone of saturation	6	6	7	[redacted]21
Phreatophyte consumption of water	15	7	7	20
General water resource of an area	[redacted]20	15	7	8
Vegetative cover effects on streamflow	12	8	8	[redacted]26
Hydraulics and geometry of channels	11	7	7	16
Stream stage forecasting	14	13	5	11
Physical quality of surface waters	17	12	4	6
Biological quality of surface waters	14	12	6	9
Bacteriological quality	12	9	5	7
Erosion and sediment production at source	14	10	8	15
Bedload and total load movement in stream	14	9	7	13
Land use effects on sediment production	11	8	8	17
Ground water movement	12	13	7	19
Physical quality of ground water	14	11	4	9
Biological quality of ground water	11	9	5	10

Area of Interest	Could be most significantly improved by:			
	Greater Areal Coverage of Present Type of Data	Increased Density of Network in Present Areas	New Types of Basic Data	Additional Basic Research
Depth-area duration of precipitation	16	18	3	8
Cyclic and/or stochastic variations in meteorological parameters	6	4	4	17
Land surface influences on generation of runoff from precipitation	13	11	9	[redacted]24
Lake evaporation	14	13	6	14
Interflow (See 2.D. 8.)	5	4	4	15
Bank storage	7	6	5	12
Water supply forecasting	12	12	7	14
Urbanization effects on runoff	10	12	6	18
Flood frequency	15	14	4	12
Flood hydrograph and overflow characteristics of streamflow (including areal flooding, detention, etc.)	16	14	5	11
Chemical quality of surface waters	18	15	5	6
Radiological quality	8	8	4	5
Organic	10	8	4	5
Suspended sediment transport in streams	17	11	4	9
Vegetation cover effects on sediment production	11	8	8	[redacted]20
Soil moisture movement	6	6	6	[redacted]20
Ground water basin storage	17	15	6	15
Chemical quality of ground water	16	16	5	9
Other (specify)	1	0.7	0.4	2

PACIFIC SOUTHWEST INTER-AGENCY COMMITTEE
WATER MANAGEMENT SUBCOMMITTEE

Summary of
QUESTIONNAIRE ON FUTURE HYDROLOGIC DATA NEEDS

PLANNING
Figures Shown are Percentages of 240 Replies

I. Nature of response:

A. I am associated with which type of organization: (Circle one)

Federal Agency	51
State Agency	25
University or College	3
Local Government (City, County, Dist.)	13
Private (non-profit)	0.4
Private (profit)	4
Research Institute	0
Other	3
No Answer	0.8

B. Geographic area of concern: (Circle one)

Entire Pacific Southwest	17
Particular Basin*	20
System of basins*	23
State*	25
Other*	13
No Answer	2

C. I am primarily concerned with: (Circle one)

Planning	100
Design	--
Administration	--
Operations	--
Research	--
Other--specify	--
No Answer	--

D. I work in the following fields: (Circle as applicable)

Water Supply	67
Soil Conservation	24
Reclamation	24
Flood Protection	43
Forecasting	13
Power	15
Water Rights	29
Navigation	5
Pollution Control (Water Quality)	37
Recreation	31
Fish and Wildlife	20
Watershed Management	25
Agriculture	25
Forestry	7
Other	9

II. Present basic data: Considering anticipated future development and conservation of land, water, and related resources, present basic data are believed to be:

	Inadequate	About Right	Too Much
Rainfall			
Daily measurements (for seasonal totals)	27	52	0
Intensity measurements	42	20	0.4
Chemical quality	17	18	0.4
Susp. solids in rainfall	8	15	0.8
Other	1	4	0
Snow			
Total snowfall	19	34	0
Depth on the ground	17	30	0
Water equivalent	25	29	0
Physical properties	8	16	0
Other	4	5	0
Dew and Fog Measurements			
Dew measurements	9	15	0.8
Fog drip	6	13	1
Other	2	7	0.4
Humidity			
Relative humidity	12	22	0
Dew point	7	18	0.4
Wet bulb	7	17	0.4
Precipitable water	10	10	0.4
Other	0	5	0
Evaporation			
From free water bodies	51	17	1
Evaporimeter	21	10	0.4
Evapotranspiration (point measurement)	33	11	0.8
Evapotranspiration (areal measurement)	40	9	0
From bare ground	32	9	0.4
Other	4	3	0
Quality of Water			
Chemical	33	26	2
Physical	28	14	0.8
Biological	29	11	0
Radiological	14	14	0.8
Bacteriological	20	14	0
Organic	22	9	0
Other	4	3	0

	Inadequate	About Right	Too Much
Temperature			
Free air (Nr. ground)	17	32	0
Upper air	10	18	0
Surface (of ground)	16	16	0
Frost (occurrence dates)	14	29	0
Soil (below surface)	20	11	0.4
Reservoirs and lakes	25	16	0.4
Streams	25	17	0
Ground water	20	15	0
Other	1	5	0
Surface Water Movement or Storage			
Time of travel	40	11	0
Stream velocity	34	18	0
Stream discharge	38	30	0.4
Streamflow volumes	37	27	0
Flood crest heights	32	20	0.4
Flood wave velocity	28	12	0
Stream and tidal stage	15	21	0
Lake or reservoir stage	11	35	0.4
Lake or reservoir volume	13	33	0.4
Interflows*	27	5	0
Other	2	4	0
Wind			
Upper air velocity	12	13	0.4
Near surface velocity	28	12	1
Prevailing direction (by day, month, or season)	20	15	0.8
Extreme winds	16	12	0.4
Total air movement	16	9	0.4
Other	0.8	3	0
Sedimentation			
Sediment production at source	47	8	0
Suspended sediment	44	13	0.8
Bedload transport	45	8	0.8
Total sediment transport	45	7	1
Stream channel aggradation and degradation	42	9	0.4

*Interflows are percolating waters reaching streams without first reaching a ground water body.

	Inadequate	About Right	Too Much
Ground Water and Soil Moisture			
Soil moisture amount	42	10	0
Phreatic surfaces (unconfined)	31	11	0.8
Piezometric surfaces (confined)	29	12	0.4
Extractions (pumping)	37	14	0.4
Transmissibility	43	6	0
Percolation	47	8	0
Permeability	46	9	0.4
Specific yield	41	8	0
Other	3	2	0
Radiation			
Incoming shortwave	15	5	0
Long wave (to surface)	16	5	0
Net radiation	20	4	0
Albedo	13	7	0
Sunshine	10	10	0.4
Cloudiness	10	10	0
Other	0.4	1	0
Lake and reservoir deposition	38	11	0.8
Other	3	3	0
Weather Conditions			
Fogginess	5	19	0.4
Hail	5	17	0.8
Glaze and rime ice storms	2	17	0.4
Pressure (barometric)	4	20	0.4
Other	1	6	0

III. There are many problem areas in hydrometeorology where the state of the art is not adequate to define the relationships. Listed below are several problem areas or basic data fields where additional information may be needed for use in solving various problems in hydrometeorology. Which action would yield the most good?

Area of Interest	Could be most significantly improved by: Greater Areal Coverage of Present Type of Data	Increased Density of Network in Present Areas	New Types of Basic Data	Additional Basic Research
Areal distribution of storm precipitation	[27]	[21]	3	11
Relation of precipitation intensities and total amounts to basin characteristics, orographic and other	13	[20]	6	18
Interception	5	8	3	13
Entry of precipitation and surface runoff into underground storage (recharge)	11	13	11	[30]
Evapotranspiration	15	13	5	[26]
Interchanges of water between surface and zone of saturation	0	9	9	[23]
Phreatophyte consumption of water	19	8	8	[26]
General water resource of an area	[25]	18	6	9
Vegetative cover effects on streamflow	15	8	9	[27]
Hydraulics and geometry of channels	13	5	8	13
Stream stage forecasting	15	12	4	7
Physical quality of surface waters	18	18	4	6
Biological quality of surface waters	14	15	6	10
Bacteriological quality	12	12	5	6
Erosion and sediment production at source	15	12	9	17
Bedload and total load movement in stream	18	13	8	15
Land use effects on sediment production	14	7	10	[20]
Ground water movement	15	14	6	[22]
Physical quality of ground water	15	14	6	8
Biological quality of ground water	13	12	5	8

Area of Interest	Could be most significantly improved by: Greater Areal Coverage of Present Type of Data	Increased Density of Network in Present Areas	New Types of Basic Data	Additional Basic Research
Depth-area duration of precipitation	[21]	[20]	2	5
Cyclic and/or stochastic variations in meteorological parameters	6	4	5	19
Land surface influences on generation of runoff from precipitation	15	12	11	24
Lake evaporation	19	17	5	18
Interflow (See 2.D. 8.)	6	3	3	15
Bank storage	6	7	7	12
Water supply forecasting	15	15	9	10
Urbanization effects on runoff	10	14	8	18
Flood frequency	16	14	4	12
Flood hydrograph and overflow characteristics of streamflow (including areal flooding, detention, etc.)	[20]	14	5	10
Chemical quality of surface waters	18	[20]	6	7
Radiological quality	8	7	3	4
Organic	11	10	4	5
Suspended sediment transport in streams	[22]	14	5	10
Vegetation cover effects on sediment production	14	7	8	[22]
Soil moisture movement	9	9	8	19
Ground water basin storage	19	19	7	18
Chemical quality of ground water	18	[20]	6	9
Other (specify)	1	0	0	0

PACIFIC SOUTHWEST INTER-AGENCY COMMITTEE
WATER MANAGEMENT SUBCOMMITTEE

Summary of
QUESTIONNAIRE ON FUTURE HYDROLOGIC DATA NEEDS

DESIGN
Figures Shown are Percentages of 69 Replies

I. Nature of response:

A. I am associated with which type of organization: (Circle one)

Federal Agency	39
State Agency	28
University or College	1
Local Government (City, County, Dist.)	22
Private (non-profit)	0
Private (profit)	9
Research Institute	0
Other	1
No Answer	0

B. Geographic area of concern: (Circle one)

Entire Pacific Southwest	16
Particular Basin	13
System of basins*	20
State*	38
Other*	10
No Answer	3

C. I am primarily concerned with: (Circle one)

Planning	--
Design	100
Administration	--
Operations	--
Research	--
Other-specify	--
No Answer	--

D. I work in the following fields: (Circle as applicable)

Water Supply	42
Soil Conservation	23
Reclamation	15
Flood Protection	32
Forecasting	20
Power	9
Water Rights	17
Navigation	4
Pollution Control (Water Quality)	25
Recreation	22
Fish and Wildlife	7
Watershed Management	19
Agriculture	15
Forestry	1
Other	13

II Present basic data: Considering anticipated future development and conservation of land, water, and related resources, present basic data are believed to be:

	Inadequate	About Right	Too Much
Rainfall			
Daily measurements (for seasonal totals)	[redacted]	[redacted]	0
Intensity measurements	[redacted]	17	1
Chemical quality	16	15	0
Susp. solids in rainfall	6	10	1
Other	3	0	0
Snow			
Total snowfall	12	28	0
Depth on the ground	16	26	1
Water equivalent	17	29	0
Physical properties	9	13	0
Other	1	3	0
Dew and Fog Measurements			
Dew measurements	7	10	1
Fog drip	6	10	1
Other	0	4	0
Humidity			
Relative humidity	4	17	0
Dew point	7	13	0
Wet bulb	4	13	0
Precipitable water	6	10	0
Other	0	1	0
Evaporation			
From free water bodies	25	15	0
Evaporimeter	10	7	0
Evapotranspiration (point measurement)	20	9	0
Evapotranspiration (areal measurement)	26	7	0
From bare ground	19	7	0
Other	3	0	0
Quality of Water			
Chemical	15	22	1
Physical	7	15	1
Biological	10	12	1
Radiological	9	9	1
Bacteriological	15	7	1
Organic	12	9	0
Other	1	3	0

	Inadequate	About Right	Too Much
Temperature			
Free air (Nr. ground)	7	26	0
Upper air	4	15	0
Surface (of ground)	6	16	0
Frost (occurrence dates)	12	19	0
Soil (below surface)	13	10	0
Reservoirs and lakes	9	12	0
Streams	13	13	0
Ground water	9	16	0
Other	0	4	0
Surface Water Movement or Storage			
Time of travel	[redacted]	7	0
Stream velocity	[redacted]	16	0
Stream discharge	[redacted]	22	0
Streamflow volumes	[redacted]	25	0
Flood crest heights	[redacted]	20	0
Flood wave velocity	[redacted]	6	0
Stream and tidal stage	17	12	0
Lake or reservoir stage	15	17	0
Lake or reservoir volume	15	19	0
Interflows*	20	3	0
Other	0	0	0
Wind			
Upper air velocity	7	15	0
Near surface velocity	12	19	0
Prevailing direction (by day, month, or season)	6	23	0
Extreme winds	9	19	0
Total air movement	3	12	0
Other	0	0	0
Sedimentation			
Sediment production at source	[redacted]	4	0
Suspended sediment	[redacted]	10	0
Bedload transport	[redacted]	4	0
Total sediment transport	[redacted]	7	0
Stream channel aggradation and degradation	[redacted]	6	0

*Interflows are percolating waters reaching streams without first reaching a ground water body.

	Inadequate	About Right	Too Much
Ground Water and Soil Moisture			
Soil moisture amount	28	10	0
Phreatic surfaces (unconfined)	15	9	0
Piezometric surfaces (confined)	15	9	0
Extractions (pumping)	22	10	0
Transmissibility	23	4	0
Percolation	[redacted]	[redacted]	0
Permeability	[redacted]	9	0
Specific yield	22	9	0
Other	1	0	0
Radiation			
Incoming shortwave	9	7	1
Long wave (to surface)	9	7	1
Net radiation	10	6	1
Albedo	9	7	0
Sunshine	4	12	0
Cloudiness	4	12	0
Other	0	0	0
Lake and reservoir deposition	[redacted]	7	0
Other	3	0	0
Weather Conditions			
Fogginess	4	15	0
Hail	3	15	0
Glaze and rime ice storms	1	16	0
Pressure (barometric)	1	16	0
Other	0	4	0

III. There are many problem areas in hydrometeorology where the state of the art is not adequate to define the relationships. Listed below are several problem areas or basic data fields where additional information may be needed for use in solving various problems in hydrometeorology. Which action would yield the most good?

Area of Interest	Could be most significantly improved by: Greater Areal Coverage of Present Type of Data	Increased Density of Network in Present Areas	New Types of Basic Data	Additional Basic Research
Areal distribution of storm precipitation	[redacted]	[redacted]	9	9
Relation of precipitation intensities and total amounts to basin characteristics, orographic and other	[redacted]	[redacted]	10	16
Interception	9	4	1	10
Entry of precipitation and surface runoff into underground storage (recharge)	10	9	4	12
Evapotranspiration	3	6	3	10
Interchanges of water between surface and zone of saturation	0	6	3	13
Phreatophyte consumption of water	13	7	1	4
General water resource of an area	19	12	6	6
Vegetative cover effects on streamflow	17	13	7	13
Hydraulics and geometry of channels	15	19	12	[redacted]
Stream stage forecasting	17	[redacted]	7	10
Physical quality of surface waters	12	6	0	1
Biological quality of surface waters	9	6	0	1
Bacteriological quality	7	6	0	3
Erosion and sediment production at source	16	9	10	16
Bedload and total load movement in stream	15	12	9	15
Land use effects on sediment production	7	10	10	[redacted]
Ground water movement	4	17	4	6
Physical quality of ground water	9	9	1	3
Biological quality of ground water	7	4	1	3

Area of Interest	Could be most significantly improved by: Greater Areal Coverage of Present Type of Data	Increased Density of Network in Present Areas	New Types of Basic Data	Additional Basic Research
Depth-area-duration of precipitation	[redacted]	[redacted]	7	19
Cyclic and/or stochastic variations in meteorological parameters	3	4	3	10
Land surface influences on generation of runoff from precipitation	[redacted]	[redacted]	12	[redacted]
Lake evaporation	3	7	3	9
Interflow (See 2.D. 8.)	1	0	4	6
Bank storage	3	6	6	4
Water supply forecasting	9	7	3	9
Urbanization effects on runoff	13	[redacted]	9	[redacted]
Flood frequency	[redacted]	[redacted]	9	[redacted]
Flood hydrograph and overflow characteristics of streamflow (including areal flooding, detention, etc.)	22	[redacted]	10	17
Chemical quality of surface waters	7	7	0	1
Radiological quality	3	1	0	1
Organic	4	4	0	1
Suspended sediment transport in streams	[redacted]	9	4	9
Vegetation cover effects on sediment production	7	12	10	[redacted]
Soil moisture movement	10	7	6	9
Ground water basin storage	16	17	6	4
Chemical quality of ground water	10	12	3	1
Other (specify)	1	1	1	3

PACIFIC SOUTHWEST INTER-AGENCY COMMITTEE
WATER MANAGEMENT SUBCOMMITTEE

Summary of
QUESTIONNAIRE ON FUTURE HYDROLOGIC DATA NEEDS

ADMINISTRATION
Figures Shown are Percentages of 99 Replies

I. Nature of response:

A. I am associated with which type of organization: (Circle one)

Federal Agency	27
State Agency	40
University or College	1
Local Government (City, County, Dist.)	25
Private (non-profit)	1
Private (profit)	2
Research Institute	0
Other	3
No Answer	2

B. Geographic area of concern: (Circle one)

Entire Pacific Southwest	15
Particular Basin*	24
System of basins*	17
State*	28
Other*	12
No Answer	3

C. I am primarily concerned with: (Circle one)

Planning	--
Design	--
Administration	100
Operations	--
Research	--
Other-specify	--
No Answer	--

D. I work in the following fields: (Circle as applicable)

Water Supply	67
Soil Conservation	16
Reclamation	16
Flood Protection	25
Forecasting	10
Power	6
Water Rights	43
Navigation	2
Pollution Control (Water Quality)	37
Recreation	26
Fish and Wildlife	20
Watershed Management	25
Agriculture	23
Forestry	7
Other	8

II. Present basic data: Considering anticipated future development and conservation of land, water, and related resources, present basic data are believed to be:

	Inadequate	About Right	Too Much
Rainfall			
Daily measurements (for seasonal totals)	26	57	0
Intensity measurements	31	30	0
Chemical quality	28	19	2
Susp. solids in rainfall	16	14	2
Other	2	6	1
Snow			
Total snowfall	11	51	1
Depth on the ground	10	46	1
Water equivalent	21	40	2
Physical properties	10	15	2
Other	1	5	2
Dew and Fog Measurements			
Dew measurements	6	19	1
Fog drip	5	19	1
Other	0	14	1
Humidity			
Relative humidity	8	28	0
Dew point	6	24	1
Wet bulb	6	20	2
Precipitable water	8	15	1
Other	0	5	1
Evaporation			
From free water bodies	48	16	3
Evaporimeter	23	10	1
Evapotranspiration (point measurement)	33	8	1
Evapotranspiration (areal measurement)	39	7	1
From bare ground	30	9	1
Other	6	3	1
Quality of Water			
Chemical	39	33	3
Physical	27	29	2
Biological	34	22	1
Radiological	22	23	3
Bacteriological	28	20	2
Organic	25	17	2
Other	3	7	2

	Inadequate	About Right	Too Much
Temperature			
Free air (Nr. ground)	11	37	1
Upper air	8	19	1
Surface (of ground)	9	21	1
Frost (occurrence dates)	11	30	1
Soil (below surface)	14	19	1
Reservoirs and lakes	19	24	2
Streams	14	27	2
Ground water	14	20	2
Other	3	8	1
Surface Water Movement or Storage			
Time of travel	29	20	1
Stream velocity	28	23	1
Stream discharge	35	30	1
Streamflow volumes	31	33	1
Flood crest heights	26	27	1
Flood wave velocity	17	18	1
Stream and tidal stage	12	20	1
Lake or reservoir stage	14	37	1
Lake or reservoir volume	17	40	1
Interflows*	23	9	0
Other	1	5	0

*Interflows are percolating waters reaching streams without first reaching a ground water body.

Wind			
Upper air velocity	9	20	1
Near surface velocity	12	25	1
Prevailing direction (by day, month, or season)	10	24	0
Extreme winds	13	17	1
Total air movement	11	16	1
Other	2	6	1
Sedimentation			
Sediment production at source	42	11	1
Suspended sediment	36	11	1
Bedload transport	28	12	2
Total sediment transport	37	11	1
Stream channel aggradation and degradation	35	13	0

	Inadequate	About Right	Too Much
Ground Water and Soil Moisture			
Soil moisture amount	32	19	1
Phreatic surfaces (unconfined)	28	14	1
Piezometric surfaces (confined)	23	15	1
Extractions (pumping)	31	19	1
Transmissibility	32	14	1
Percolation	40	15	1
Permeability	39	16	1
Specific yield	36	14	1
Other	0	4	0
Radiation			
Incoming shortwave	8	9	2
Long wave (to surface)	8	9	2
Net radiation	10	9	2
Albedo	7	9	2
Sunshine	9	11	2
Cloudiness	8	9	2
Other	3	4	2
Lake and reservoir deposition	31	14	1
Other	1	5	1
Weather Conditions			
Fogginess	2	19	1
Hail	3	17	1
Glaze and rime ice storms	3	15	1
Pressure (barometric)	4	24	0
Other	3	7	1

III. There are many problem areas in hydrometeorology where the state of the art is not adequate to define the relationships. Listed below are several problem areas or basic data fields where additional information may be needed for use in solving various problems in hydrometeorology. Which action would yield the most good?

Area of Interest	Could be most significantly improved by: Greater Areal Coverage of Present Type of Data	Increased Density of Network in Present Areas	New Types of Basic Data	Additional Basic Research
Areal distribution of storm precipitation	16	[illegible]	3	4
Relation of precipitation intensities and total amounts to basin characteristics, orographic and other	12	14	3	14
Interception	5	7	4	10
Entry of precipitation and surface runoff into underground storage (recharge)	9	12	7	[illegible]
Evapotranspiration	15	13	4	[illegible]
Interchanges of water between surface and zone of saturation	6	7	2	[illegible]
Phreatophyte consumption of water	16	9	8	[illegible]
General water resources of an area	[illegible]	19	2	10
Vegetative cover effects on streamflow	11	11	6	[illegible]
Hydraulics and geometry of channels	13	8	5	14
Stream stage forecasting	18	16	3	9
Physical quality of surface waters	17	13	2	6
Biological quality of surface waters	[illegible]	14	5	6
Bacteriological quality	19	12	5	4
Erosion and sediment production at source	17	13	2	10
Bedload and total load movement in stream	14	9	1	9
Land use effects on sediment production	12	12	7	14
Ground water movement	15	15	9	[illegible]
Physical quality of ground water	14	13	3	10
Biological quality of ground water	5	10	5	10

Area of Interest	Could be most significantly improved by: Greater Areal Coverage of Present Type of Data	Increased Density of Network in Present Areas	New Types of Basic Data	Additional Basic Research
Depth-area duration of precipitation	15	18	2	5
Cyclic and/or stochastic variations in meteorological parameters	6	6	1	12
Land surface influences on generation of runoff from precipitation	10	11	8	[illegible]
Lake evaporation	16	16	3	17
Interflow (See 2.D. 8.)	5	7	2	13
Bank storage	12	9	3	16
Water supply forecasting	17	15	5	12
Urbanization effects on runoff	8	13	7	17
Flood frequency	17	16	10	8
Flood hydrograph and overflow characteristics of streamflow (including areal flooding, detention, etc.)	18	14	4	8
Chemical quality of surface waters	[illegible]	13	3	3
Radiological quality	10	9	[illegible]	3
Organic	15	8	3	5
Suspended sediment transport in streams	15	10	2	10
Vegetation cover effects on sediment production	17	13	7	14
Soil moisture movement	10	12	8	19
Ground water basin storage	16	14	12	16
Chemical quality of ground water	16	13	5	5
Other (specify)	1	1	0	1

PACIFIC SOUTHWEST INTER-AGENCY COMMITTEE
WATER MANAGEMENT SUBCOMMITTEE

Summary of
QUESTIONNAIRE ON FUTURE HYDROLOGIC DATA NEEDS

OPERATIONS
Figures Shown are Percentages of 146 Replies

I. Nature of response:

A. I am associated with which type of organization: (Circle one)

Federal Agency	47
State Agency	22
University or College	1
Local Government (City, County, Dist.)	20
Private (non-profit)	2
Private (profit)	6
Research Institute	0
Other	0
No Answer	1

B. Geographic area of concern: (Circle one)

Entire Pacific Southwest	4
Particular Basin*	36
System of basins*	16
State*	24
Other*	17
No Answer	2

C. I am primarily concerned with: (Circle one)

Planning	--
Design	--
Administration	--
Operations	100
Research	--
Other-specify	--
No Answer	--

D. I work in the following fields: (Circle as applicable)

Water Supply	55
Soil Conservation	16
Reclamation	9
Flood Protection	25
Forecasting	29
Power	9
Water Rights	25
Navigation	1
Pollution Control (Water Quality)	29
Recreation	15
Fish and Wildlife	10
Watershed Management	15
Agriculture	25
Forestry	1
Other	5

II. Present basic data: Considering anticipated future development and conservation of land, water, and related resources, present basic data are believed to be:

	Inadequate	About Right	Too Much
Rainfall			
Daily measurements (for seasonal totals)	25	57	1
Intensity measurements	41	25	0
Chemical quality	17	18	0
Susp. solids in rainfall	12	15	0
Other	2	2	0
Snow			
Total snowfall	16	43	0
Depth on the ground	19	36	0
Water equivalent	25	39	0
Physical properties	11	14	1
Other	5	2	0
Dew and Fog Measurements			
Dew measurements	16	12	1
Fog drip	14	11	1
Other	3	2	0
Humidity			
Relative humidity	17	26	0
Dew point	14	19	0
Wet bulb	12	16	0
Precipitable water	15	12	0
Other	2	0	0
Evaporation			
From free water bodies	48	14	0
Evaporimeter	22	9	0
Evapotranspiration (point measurement)	32	10	0
Evapotranspiration (areal measurement)	36	6	0
From bare ground	32	7	0
Other	5	1	0
Quality of Water			
Chemical	29	27	0
Phyribal	24	21	0
Biological	25	16	0
Radiological	16	16	0
Bacteriological	22	18	0
Organic	20	14	0
Other	5	5	0

	Inadequate	About Right	Too Much
Temperature			
Free air (Hr. ground)	24	37	1
Upper air	23	16	0
Surface (of ground)	22	17	0
Frost (occurrence dates)	10	27	0
Soil (below surface)	24	12	0
Reservoirs and lakes	21	19	0
Streams	19	22	0
Ground water	12	19	0
Other	1	4	0
Surface Water Movement or Storage			
Time of travel	42	16	0
Stream velocity	24	25	0
Stream discharge	29	36	1
Streamflow volumes	25	34	1
Flood crest heights	23	33	0
Flood wave velocity	26	14	0
Stream and tidal stage	12	25	0
Lake or reservoir stage	8	30	0
Lake or reservoir volume	8	41	0
Interflows*	24	8	0
Other	1	3	0

*Interflows are percolating waters reaching streams without first reaching a ground water body.

Wind			
Upper air velocity	19	18	0
Near surface velocity	28	21	0
Prevailing direction (by day, month, or season)	16	23	0
Extreme winds	16	18	0
Total air movement	12	17	0
Other	3	3	0
Sedimentation			
Sediment production at source	28	8	0
Suspended sediment	22	16	0
Bedload transport	23	11	0
Total sediment transport	23	12	0
Stream channel aggradation and degradation	27	8	0

	Inadequate	About Right	Too Much
Ground Water and Soil Moisture			
Soil moisture amount	31	14	0
Phreatic surfaces (unconfined)	19	13	0
Piezometric surfaces (confined)	21	12	0
Extractions (pumping)	22	12	0
Transmissibility	26	5	0
Percolation	32	9	0
Permeability	34	9	0
Specific yield	26	8	0
Other	3	1	0
Radiation			
Incoming shortwave	18	9	0
Long wave (to surface)	19	9	0
Net radiation	19	10	0
Albedo	15	12	0
Sunshine	12	14	0
Cloudiness	12	14	0
Other	2	1	0
Lake and reservoir deposition	26	12	1
Other	5	2	1
Weather Conditions			
Fogginess	8	23	0
Hail	10	21	1
Glaze and rime ice storms	8	20	1
Pressure (barometric)	8	26	0
Other	3	6	0

III. There are many problem areas in hydrometeorology where the state of the art is not adequate to define the relationships. Listed below are several problem areas or basic data fields where additional information may be needed for use in solving various problems in hydrometeorology. Which action would yield the most good?

Area of Interest	Could be most significantly improved by:			
	Greater Areal Coverage of Present Type of Data	Increased Density of Network in Present Areas	New Types of Basic Data	Additional Basic Research
Areal distribution of storm precipitation	17	[illegible]	3	8
Relation of precipitation intensities and total amounts to basin characteristics, orographic and other	10	18	8	13
Interception	2	4	5	12
Entry of precipitation and surface runoff into underground storage (recharge)	9	6	8	19
Evapotranspiration	11	9	1	17
Interchanges of water between surface and zone of saturation	4	3	8	16
Phreatophyte consumption of water	10	8	4	14
General water resource of an area	12	14	6	7
Vegetative cover effects on streamflow	8	8	6	[illegible]
Hydraulics and geometry of channels	7	7	5	14
Stream stage forecasting	13	11	4	14
Physical quality of surface waters	19	11	3	6
Biological quality of surface waters	15	10	5	9
Bacteriological quality	13	7	1	8
Erosion and sediment production at source	8	7	7	10
Bedload and total load movement in stream	7	5	1	10
Land use effects on sediment production	8	10	4	7
Ground water movement	10	7	5	18
Physical quality of ground water	14	10	5	8
Biological quality of ground water	11	7	5	11

Area of Interest	Could be most significantly improved by:			
	Greater Areal Coverage of Present Type of Data	Increased Density of Network in Present Areas	New Types of Basic Data	Additional Basic Research
Depth-area duration of precipitation	12	15	2	5
Cyclic and/or stochastic variations in meteorological parameters	3	3	5	15
Land surface influences on generation of runoff from precipitation	10	6	8	19
Lake evaporation	12	9	6	13
Interflow (See 2.9. 8.)	3	4	5	14
Bank storage	7	5	5	9
Water supply forecasting	10	10	9	[illegible]
Urbanization effects on runoff	8	7	3	15
Flood frequency	12	9	2	11
Flood hydrograph and overflow characteristics of streamflow (including areal flooding, detention, etc.)	8	13	4	12
Chemical quality of surface waters	12	14	4	5
Radiological quality	5	5	0	5
Organic	5	6	2	4
Suspended sediment transport in streams	8	11	3	6
Vegetation cover effects on sediment production	9	5	3	12
Soil moisture movement	6	7	5	18
Ground water basin storage	12	10	6	14
Chemical quality of ground water	12	11	2	8
Other (specify)	0	0	0	3

PACIFIC SOUTHWEST INTER-AGENCY COMMITTEE
WATER MANAGEMENT SUBCOMMITTEE

Summary of
QUESTIONNAIRE ON FUTURE HYDROLOGIC DATA NEEDS

RESEARCH
Figures Shown are Percentages of 100 Replies

I. Nature of response:

A. I am associated with which type of organization: (Circle one)

Federal Agency	57
State Agency	0
University or College	35
Local Government (City, County, Dist.)	3
Private (non-profit)	0
Private (profit)	3
Research Institute	1
Other	1
No Answer	0

B. Geographic area of concern: (Circle one)

Entire Pacific Southwest	24
Particular Basin*	19
System of basins*	10
State*	32
Other*	14
No Answer	1

C. I am primarily concerned with: (Circle one)

Planning	--
Design	--
Administration	--
Operations	--
Research	100
Other-specify	--
No Answer	--

D. I work in the following fields: (Circle as applicable)

Water Supply	52
Soil Conservation	23
Reclamation	10
Flood Protection	16
Forecasting	14
Power	3
Water Rights	8
Navigation	4
Pollution Control (Water Quality)	29
Recreation	7
Fish and Wildlife	3
Watershed Management	37
Agriculture	32
Forestry	6
Other	15

II. Present basic data: Considering anticipated future development and conservation of land, water, and related resources, present basic data are believed to be:

	Inadequate	About Right	Too Much
Rainfall			
Daily measurements (for seasonal totals)	[redacted]	[redacted]	0
Intensity measurements	[redacted]	24	0
Chemical quality	[redacted]	20	0
Susp. solids in rainfall	25	17	0
Other	4	8	0
Snow			
Total snowfall	29	[redacted]	0
Depth on the ground	26	28	0
Water equivalent	[redacted]	26	0
Physical properties	24	15	0
Other	8	4	0
Dew and Fog Measurements			
Dew measurements	28	18	0
Fog drip	22	17	0
Other	1	9	0
Humidity			
Relative humidity	28	29	3
Dew point	29	20	0
Wet bulb	23	24	0
Precipitable water	26	16	0
Other	3	4	0
Evaporation			
From free water bodies	[redacted]	20	1
Evaporimeter	26	21	4
Evapotranspiration (point measurement)	[redacted]	8	2
Evapotranspiration (areal measurement)	[redacted]	7	1
From bare ground	[redacted]	10	1
Other	8	6	0
Quality of Water			
Chemical	[redacted]	20	0
Physical	[redacted]	18	0
Biological	[redacted]	17	0
Radiological	26	17	0
Bacteriological	27	17	0
Organic	[redacted]	13	0
Other	7	8	0

	Inadequate	About Right	Too Much
Temperature			
Free air (Mr. ground)	[redacted]	[redacted]	0
Upper air	22	25	0
Surface (of ground)	[redacted]	21	0
Frost (occurrence dates)	19	28	2
Soil (below surface)	[redacted]	17	0
Reservoirs and lakes	23	18	1
Streams	28	19	0
Ground water	26	18	0
Other	3	4	0
Surface Water Movement or Storage			
Time of travel	[redacted]	15	0
Stream velocity	28	27	0
Stream discharge	[redacted]	30	0
Streamflow volumes	[redacted]	28	0
Flood crest heights	[redacted]	21	0
Flood wave velocity	[redacted]	13	0
Stream and tidal stage	10	25	0
Lake or reservoir stage	8	[redacted]	0
Lake or reservoir volume	9	[redacted]	0
Interflows*	[redacted]	10	0
Other	2	4	0

*Interflows are percolating waters reaching streams without first reaching a ground water body.

Wind			
Upper air velocity	19	24	0
Near surface velocity	[redacted]	21	0
Prevailing direction (by day, month, or season)	22	28	1
Extreme winds	23	22	0
Total air movement	19	20	0
Other	5	4	0
Sedimentation			
Sediment production at source	[redacted]	8	0
Suspended sediment	[redacted]	14	0
Bedload transport	[redacted]	8	0
Total sediment transport	[redacted]	12	0
Stream channel aggradation and degradation	[redacted]	9	0

	Inadequate	About Right	Too Much
Ground Water and Soil Moisture			
Soil moisture amount	[redacted]	7	1
Phreatic surfaces (unconfined)	[redacted]	12	1
Piezometric surfaces (confined)	[redacted]	9	1
Extractions (pumping)	[redacted]	21	1
Transmissibility	[redacted]	4	1
Percolation	[redacted]	6	1
Permeability	[redacted]	5	1
Specific yield	[redacted]	11	1
Other	3	3	1
Radiation			
Incoming shortwave	[redacted]	11	0
Long wave (to surface)	[redacted]	8	0
Net radiation	[redacted]	6	0
Albedo	[redacted]	7	0
Sunshine	[redacted]	16	0
Cloudiness	[redacted]	16	0
Other	4	2	0
Lake and reservoir deposition	31	12	0
Other	6	3	0
Weather Conditions			
Fogginess	6	[redacted]	0
Hail	5	[redacted]	0
Glaze and rime ice storms	7	[redacted]	0
Pressure (barometric)	6	[redacted]	0
Other	0	12	0

III. There are many problem areas in hydrometeorology where the state of the art is not adequate to define the relationships. Listed below are several problem areas or basic data fields where additional information may be needed for use in solving various problems in hydrometeorology. Which action would yield the most good?

Area of Interest	Could be most significantly improved by:			
	Greater Areal Coverage of Present Type of Data	Increased Density of Network in Present Areas	New Types of Basic Data	Additional Basic Research
Areal distribution of storm precipitation	[23]	[24]	10	18
Relation of precipitation intensities and total amounts to basin characteristics, orographic and other	16	18	8	[26]
Interception	7	2	15	[21]
Entry of precipitation and surface runoff into underground storage (recharge)	13	7	[21]	[41]
Evapotranspiration	13	12	18	[45]
Interchanges of water between surface and zone of saturation	10	5	16	[35]
Phreatophyte consumption of water	13	6	13	[30]
General water resource of an area	[20]	12	16	13
Vegetative cover effects on streamflow	10	7	14	[45]
Hydraulics and geometry of channels	8	6	9	[26]
Stream stage forecasting	11	9	9	[20]
Physical quality of surface waters	[20]	6	10	13
Biological quality of surface waters	14	7	15	16
Bacteriological quality	13	4	13	15
Erosion and sediment production at source	[21]	11	16	[25]
Bedload and total load movement in stream	13	5	[20]	[21]
Land use effects on sediment production	13	8	14	[25]
Ground water movement	8	10	13	[28]
Physical quality of ground water	18	12	7	[20]
Biological quality of ground water	11	9	9	[21]

Area of Interest	Could be most significantly improved by:			
	Greater Areal Coverage of Present Type of Data	Increased Density of Network in Present Areas	New Types of Basic Data	Additional Basic Research
Depth-area duration of precipitation	14	19	5	13
Cyclic and/or stochastic variations in meteorological parameters	12	8	6	[30]
Land surface influences on generation of runoff from precipitation	10	9	11	[40]
Lake evaporation	14	14	8	15
Interflow (See 2.D. 8.)	9	6	8	[31]
Bank storage	9	7	7	19
Water supply forecasting	10	11	7	19
Urbanization effects on runoff	15	12	5	[25]
Flood frequency	14	14	3	16
Flood hydrograph and overflow characteristics of streamflow (including areal flooding, detention, etc.)	13	12	6	17
Chemical quality of surface waters	[25]	14	11	13
Radiological quality	16	11	10	14
Organic	15	8	9	14
Suspended sediment transport in streams	19	12	7	17
Vegetation cover effects on sediment production	10	10	19	[36]
Soil moisture movement	5	8	16	[42]
Ground water basin storage	18	19	12	[24]
Chemical quality of ground water	[21]	[22]	9	[20]
Other (specify)	1	2	2	3